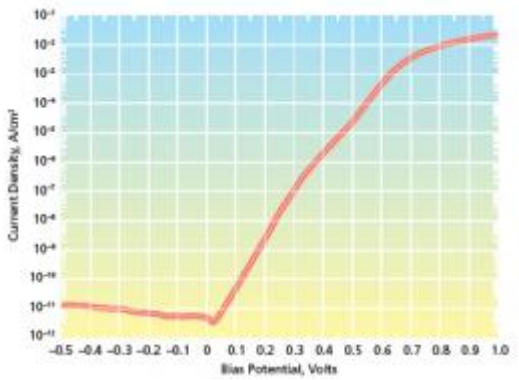
Large-Area Vacuum Ultraviolet Sensors

These devices exhibit very low dark currents.

Pt/(n-doped GaN) Schottky-barrier diodes having active areas as large as 1 cm square have been designed and fabricated as prototypes of photodetectors for the vacuum ultraviolet portion (wavelengths ≈200 nm) of the solar spectrum. In addition to having adequate sensitivity to photons in this wavelength range, these photodetectors are required to be insensitive to visible and infrared components of sunlight and to have relatively low levels of dark current.



Current Density vs. Voltage was determined from measurements on device of the type described in the text." class="caption" align="right">In preparation for fabricating a batch of assorted prototype detectors, a cplane (0001-plane) sapphire wafer was subjected to a rigorous cleaning by use of an acid and an organic solvent. Fabrication began with low-pressure metalorganic vapor-phase epitaxy of four GaN layers on the sapphire wafer: The first was a 25-nm-thick GaN nucleation layer. The second was a thicker GaN buffer layer to serve as a template for epitaxial growth. The third was a 3- μm-thick GaN epilayer containing electron- donor (n) doping at a density of 4.8×10^{18} cm^{-3}. The fourth was a 0.75- μm-thick GaN epilayer n-doped at a density of $\approx 10^{16}$ cm^{-3}.

Four masks were used to define features of devices having Schottky contact areas ranging up to the aforementioned maximum of 1 cm square. Mesas (one for each device) were first defined by use of conventional photolithography and chlorine- bromine reactive-ion etching for complete removal of the n epilayer. Metal patterns, each consisting of a 10-nm-thick layer of Ti followed by a 10-nm-thick layer of Ni followed by a 150-nm-thick layer of Al, were defined at the bottoms of the mesas by means of a lift-off procedure and electron-beam evaporation. These metal patterns were annealed at a temperature of 500 °C for 10 minutes in flowing nitrogen to form ohmic contacts.

Next, semitransparent Pt Schottky contacts having a thickness of 10 nm were defined on the tops of the mesas by means of a lift-off procedure. Contact rings, each consisting of a 30-nm-thick layer of Pt followed by a 150-nm-thick layer of Au, were formed on the peripheries of the semitransparent Pt Schottky areas by electronbeam evaporation and lift-off.

In preliminary tests of the electrical characteristics of these devices, forward and reverse current-vs.-voltage characteristics were measured in a dark enclosure. The measurements confirmed that as desired, these devices are characterized by low levels of dark current at low reverse bias voltage: For example, one device having an active area of 0.25 cm^2 exhibited a leakage current density of only 14 pA/cm^2 at a reverse bias of 0.5 V (see figure).

This work was done by Shahid Aslam and David Franz of Raytheon Co. for Goddard Space Flight Center. GSC-14777-1